Bonneville Power Administration
Fish and Wildlife Program FY99 Proposal Form

Section 1. General administrative information

Title INTRODUCING SYSTEMS SCIENCE TO PLANNING AND IMPLEMENTING FISH AND WILDLIFE RECOVERY IN THE WATERSHED

Bonneville Project: 8025

Applicant: Ducks Unlimited, Inc.

Business Acronym: DU

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Subcontractors:

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NPPC Program Measure Number:

NPPC guidance - The Fish and Wildlife Program (FWP) and The Integrated Framework - Two Council initiatives support a new approach to watershed management. The first is the FWP (1994) which is replete with references to watershed and ecosystem approaches:

- Section **7** of the FWP (Coordinating Production and Habitat) calls for (paraphrasing)…an ecosystem approach to species recovery driven by the needs of species, populations and watersheds, building on the input of local communities…using a total watershed perspective, the elements of which….when viewed together constitute watershed planning, using model watersheds to pioneer watershed oriented techniques;
- **7.0B** describes a 10-year implementation plan in which managers are asked to employ …acknowledged watershed plans, and…restore degraded areas;
- **7.6A** asks for the coordination of human activities on a watershed management basis;
- **7.6 B** describes coordinating habitat projects integrated across broader watershed improvement efforts with priorities cast in benefit:cost evaluations in dollars;
- **7.6 C** requests accelerated restoration across jurisdictional boundaries and watershed assessment stream reach-by-stream reach, leading to watershed management through locally adopted watershed plans;
- **7.6 D** discusses quantitative habitat objectives which imply some way of objectively projecting the effects of planned actions and auditing milestones toward achieving the objectives (e.g. $<60^0$ F in spawning areas and $< 68^0$ elsewhere in the stream);
- **7.6 E** reinforces the need for timely actions and results;
- **7.7 B** notes that the experience gained in the model watersheds will lead to approaches for other subbasins, a process which will take decades but which requires incremental progress (presumably measurable) each year, although the Council encourages experimenting with the approaches - the essence of adaptive management which is a basic premise of the program. In **7.7 B2** the Council encourages a gap analysis and implies something more when it encourages the identification of " …key factors limiting productivity"… and "identifying on-the-ground actions to address key limiting factors".

Subbasin: Snake River Floodplain / Eastern Oregon watersheds

SECTION 2. Key Words

Mark	**Programmatic Categories**	Mark	**Activities**	Mark	**Project Types**
__+_	Anadromous fish	_+__	Construction	_x__	Watershed
__+_	Resident fish	_+___	O&M	____	Biodiveristy/Genetics
__x_	Wildlife	____	Production	____	Population Dynamics
____	Oceans/ estuaries	___	Research	_+___	Ecosystems
____	Climate	_+__	Monitoring/Eval	____	Flow/survival
____	Other	_+__	Resource mgmt	____	Fish disease
		_x__	Planning/admin	____	Supplementation
		____	Enforcement	_+__	Wildlife habitat enhancement/restoration
		____	Acquisitions		

SECTION 3. Relationship to other Bonneville projects

Project #	Project Title/description	Nature of Relationship
	Floodplain inundation	**Restore hydrologic connections**
	Loss of riparian component	**Restore native riparian communities**

SECTION 4. Objectives, tasks and schedules

Objectives and Tasks Table

Obj # (1,2,3)	Objective	Task (a,b,c)	Task
Phase 1: Obj #1	Watershed Analysis, Planning and Work Planning	A	Set up and run central office
		B	Coordinate, venue and materials
		C	Conduct workshops
		D	Data collection
		E	Develop models
		F	Data, parameterize, run, debug
		G	Review data and model
		H	Sensitivity tests
		I	Two model “exploration” workshops
		J	Adjust models
		K	Write-up
		L	Web site development

		M	Implementation planning
		N	Twelve nested watershed plans
		O	Set up subgroups
		P	Develop critical paths, budgets, for each watershed
		Q	Coordinators
		R	Work groups
		S	System-wide model integration
		T	PATH
		U	EDT
		V	Coordination with RASP
		W	Command, control and communication
		X	Publish
Phase 2: Obj #1	Watershed Analysis	A	Collect all historic and currently available data, both published and grey, as well as anecdotal from on-site discussions with residents;
		B	Focus on information which the model indicates is most important to goals defined by workshop participants
2	Channel Restoration and Riparian Revegetation	A	Identify nearby baseline stable reference streams
		B	Inventory/monitor/map stream width, velocity, discharge, slope, energy, roughness, sediment load, sediment size, sinuosity, particle size, entrenchment, soils, vegetation
		C	Classify stream
		D	Historic cause-effect analysis of problem
		E	Design channel
		F	Estimate cut and fill, equipment
		G	EIA
		H	Permits
		I	Construct temporary bypass and settling ponds
		J	Survey and stake alignments
		K	Construction
		L	Place revetments, barriers, culverts
		M	Revegetate

		N	Line or pipe ditches
		O	Fish screen ditches
3	Range restoration and management	A	Contour trenching/rilling
		B	Seeding and mulching
		C	Tubing/planting
		D	Fencing riparian (both sides) and upland pastures
		E	Gully stabilization and reclamation
4	Reforestation, forest and slope stabilization	A	Train planters
		B	Site evaluation for standoffs, snag/dead wood, and shrub retention
		C	Plant seedlings with innocula
		D	Decommission roads (seed)
		E	Install drain/culvert filters
5	Wetland restoration in the watershed	A	Wet meadow road re-alignment
		B	Raising culvert inlets, placing drop inlets in wet meadows
		C	Re-routing ditches, berms and drains and installing closely spaced culverts and lead-out ditches in wet meadows
		D	Planting woody buffer strips in wet meadows
		E	Levee setback/breaching, floodplain liberation
		F	Returning agricultural fields to wetlands
		G	Modification of impoundments (e.g. reservoirs arm) to wetland
		H	Riparian wetland restoration

Objective Schedules and Costs

Objective #	Start Date	End Date	Cost %
Phase 1, Obj #1	Feb/98	Feb/99	1,143,000 (2%)
Phase 2, Obj #1	Jul/98	Jul/99	23,760 (0.05%)
Phase 2, Obj #2	Jun/98	Jun/01	12,712,000 (30%)
Phase 2, Obj #3	Sep/98	Jun/01	5,128,000 (12%)
Phase 2, Obj #4	Sep/98	Mar/01	1,152,000 (2%)
Phase 2, Obj #5	Sep/98	Jun/01	23,040,000 (54%)
			TOTAL
			42,055,760 (100%)

Schedule constraints: Weather, river water levels, permitting,

Completion Date:Phase 1 will be complete in Feb/99. Phase 2, the implementation of restoration of nested watersheds, will be complete by Jun/01.

SECTION 5. Budget

FY98 Budget by line item

Item	Note	FY98
Personnel		$398,000
Fringe Benefits		$ 92,000
Supplies, materials, non-expendable property		$ 30,000
Travel		$ 40,000
Indirect Costs	Overhead/Admin	$228,000
Subcontracts	Consultants	$355,000
TOTAL		$1,143,000

Outyear Costs

Outyear Costs	FY 1999	FY 00	FY 01	FY 02
Total Budget	$7,500,000	$16,400,000	$17,000,000	
O&M as % of total	2%	2%	3%	

SECTION 6. Abstract

The first goal of this project is the efficient employment of a tested ecosystem planning process using ecosystem theory and methods of systems analysis. Twelve nested watersheds will be examined using models such as EDT, and output will be linked to system-wide mainstem models (PATH). The 8-month planning element of the proposed four years of work is minimized because it is very effiecient and product-oriented, using the Integrated Planning Technology protocol. The workshop products, systematically analyzed, objectively indicate the interventions most likely to be productive and economical, while pointing to impacts and costs of these policies. The requirement for local ownership of such a watershed-level effort is absolute for goal-setting, data collection, access, and sustainability. The second goal is to employ methods of watershed management (including restoration and rehabilitation) specifically designed to reconcile western land uses with functions of wildlands.

SECTION 7. Project Description

a. Technical and/or scientific background

Recent efforts to analyze and manage watersheds in the Columbia River Basin demonstrate significant effort, commitment of resources, and progress in a number of useful but essentially dispersed and unrelated projects. However, contribution of science-based ecosystem-level analysis and planning at the watershed level is largely missing. It is our observation that to date, "watershed" work has attacked:

• the most obviously degraded areas in a watershed (an overgrazed riparian strip, point source of pollution, 'dozing in stream to divert for irrigation, etc.). The activities are identified by a sort of gap analysis - a logical initial step in prioritizing actions and usually used to identify critical acquisitions missing from the inventory of protected ecosystems - i.e. "gaps" in coverage. For example, the process in the Grande Ronde, involves an inventory and needs assessment of the tributaries and landscapes, and a review of relevant existing work and policy. Meetings of stakeholders are held to assess and plan actions which are then prioritized and implemented as the program continues to be managed and updated;

• the concerns and needs of the squeakiest wheels of a watershed planning group which do not necessarily relate as much to a systematic, integrated natural resource management and restoration effort as to the needs of an operator or agency (e.g. see Table 1. ODOT road work and upland fencing for ranchers are the two largest categories supported).

Table 1. Number and cost (x1000) by category of project - Grande Ronde Model Watershed 1996 early action projects

Fish Passage		Roads/ trails	Irrigation	Range imprvmt	Ripar/ stream enhancmnt	Tourism - recreation	Forest mgt	Wildlife	Urban/ water quality
#	1	8	3	10	10	2	0	0	0
$	49	228	39	175	145	6	0	0	0

• the inventory of watershed attributes, often optimistically called "watershed analysis" and particularly focused on pattern (e.g. features and elements such as number of redds or roads) rather than driving processes (e.g. trophic relationships and efficiency of energy transfer).

These approaches do not rely on understanding the integrated functioning and control of watershed ecosystems to identify implementation activities. Another problem of past and current efforts is identification of a useful, workable scale for watershed interventions. This proposal describes such a fundamental attribute of a watershed restoration and management intervention.

The above issues of integration and useful scale lead to addressing another shortfall of watershed work to date - the inability to rapidly, and effectively leverage a successful watershed approach to the several score sub-basins and hundreds of watersheds. Absent an objective and replicable systems vision and method, it is difficult to avoid floundering in process, and to avert the simultaneous expenditure of large sums of money and accelerated loss of faunal diversity and productivity. Naiman (1992) sees “an increasingly popular impression that the process of watershed management is becoming more important than the actual discovery and implementation of new knowledge”.

We propose to augment and assist current efforts by responding to the need for systems science in current and future watershed planning. We also propose to link such systems planning to implementation and monitoring of the plan.

Proposal Objectives - 1. Goals

1.1 The first goal of this project is the efficient (i.e. rapid) employment of a tested ecosystem planning process using ecosystem theory and methods of systems analysis. It is a process designed to *minimize process* and guide integrated watershed management actions, particularly restoration and rehabilitation. Because of the slide to extinctions and the lack of system-wide response to the interventions attempted to date, it is a goal of this proposed project to offer an alternative ecosystem planning approach which is immediately useful in most watersheds of the Basin while not suggesting a one-size-fits-all watershed planning process which is rigid. To achieve these goals requires marshaling knowledge and experience not yet deployed in the current watershed programs. The finality and certitude of extinctions are a specter of increasing probability in the Columbia Basin. Currently about half of the anadromous fish stocks have become extinct, many of the remainder are at the verge of extinction. “Relaxation” or loss of terrestrial fauna occurs as habitats are increasingly fragmented by land uses - e.g. a decline of 26% at Mt. Ranier National Park in 50 years (Harris 1984). These records of diminishing diversity generates an important requirement of a watershed approach, speed. The pace of extinctions has resulted in a clock ticking which overshadows and influences the watershed management approaches we choose in the Basin. Many of the remaining stocks of anadromous salmonids in the Basin are below minimum escapement goals (roughly 300-1000 depending on run variability) for population viability and persistence (NMFS 1995). Given the lack of response of these stocks to the past 17 years of program efforts, their existence in the short-term is questionable (see, for example, the trend lines graphed in Section I of the NPPC Program 1994, and NRC 1996).

1.2 The second goal is to employ methods of watershed management (including methods of restoration and rehabilitation) specifically designed to reconcile western land uses (such as logging, grazing, agriculture, and recreation) with functions of wildlands (such as natural rather than engineered maintenance of natural diversity and productivity);

1.3 A good reason to use an ecosystem approach is the ability it provides to link the subject matter to larger issues and a conceptual framework. This is certainly a goal for the work proposed here. The decision to examine the effects of combining the dynamics of six watersheds in a sub-basin to examine the outputs and meaning for the larger unit is a novel departure. Although less interactive, input will employ the existing knowledge and spreadsheet models such as EDT, and output will be linked to system-wide mainstem models (PATH). Output can be used for a host of analyses from economic to political. An ecosystem model should not be a guild-centered and guild-used tool.

2 Objectives

2.1 Develop twelve user defined, goal-directed ecosystem models of twelve watersheds;

2.2 involve watershed residents as well as experts in development of watershed models to inform the models, confer ownership, and enhance the likelihood of their understanding and use**;**

2.3 test at least four management/restoration policies for each watershed to assess plausible economic and environmental costs and benefits;

2.4 test the sensitivity of goal variables to different elements (variables) or combination of elements (feedback loops) in the ecosystem, thereby identifying priorities for restoration and management actions as well as missing or suspect data which need to be collected;

2.5 estimate by simulation, the time and effort required to achieve a measurable response to implementation actions indicated with policy testing. This level, analogous to the acceptable level of sampling on a species-area curve, will conclude the second phase of this project. It empirically establishes and demonstrates the utility of the systems method employed (the third phase being complete implementation);

2.6 producing a work plan based upon the simulated policies which show most promise and least impact;

2.7 making the data and simulations available on the Web;

2.8 initiate activities designed in the Watershed Plan (implement the Plan) to a stage where:

- the integrated activities show measurable results and interactions at the watershed level (e.g. escapement, summer stream flows, or additional species) as well as at the site. This is termed the "threshold of effects" and is to be estimated by simulation. It is a form of validation of the method. Empirical evidence indicates significant response to treatments at about 2/3 of the implementatio.

a. Rationale and significance to Regional Programs

RELEVANCE TO COLUMBIA BASIN FISH AND WILDLIFE PROGRAM (or other regional programs)

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The second approach represents a response to a recent programmatic review by the Independent Scientific Group retained by the NPPC (ISG 1996). The take-home message is simply that the FWP has suffered due to a confused and uncoordinated approach resulting from poor planning. The Council supported development of the report (Return to the River) and has accepted "An Integrated Framework for Fish and Wildlife Management in the Columbia River Basin" (NPPC 1997) which was generated by the findings described in Return to the River. The fundamental flaw identified by the (ISG 1996), was the attempt to fit a technical fix to environmental problems one-at-a-time (the laundry list approach), while not addressing interactions or dynamic behavior (over time) of ecosystem components in planning actions. They decry a pastiche or anarchy of fundamentally unrelated projects responding to a wide variety of goals, often not at a watershed or ecosystem level (e.g. "build a hatchery" or "delist a stock"). Even though each project may appear to usefully address an issue of fish and wildlife in the Basin, there is no integrating thesis, and certainly, little science except in the conduct of the individual projects. The Framework describes a solution to the way the Program has developed over the past 17 years. In fact it represents a sea-change in planning. It is an iterative process of goal setting, science-based system bounding and defining (the conceptual foundation), strategy and tactic development, and feedback. This Framework is necessary to realize adaptive FWP management. The Framework and IPT describe nearly identical processes (below), although IPT depends upon the participation of the knowledge and acceptance of watershed residents (as suggested in Sections 7, 7.6 A, and 7.6 C of the FWP). A current issue is how to move toward the Framework given the inertia of hundreds of current individual FWP projects (some active for more than 10 years and projected out through the end of the (this) millennium). This proposal seeks to initiate such a process in the watersheds.

Methods - I Watershed Analysis - The Forest Service has the most organized, systematic, and extensive experience with watershed analysis in the northwest. The initiative of the FS is understandable when more than 95% of streamflow originates from forested and alpine lands in Washington and Oregon, most administered by the Forest Service. Initially in response to attempts to define "ecosystem management" and most recently in response to the watershed analyses mandated by the Northwest Forest Plan, the FS began analyzing watersheds in mid-1994. By early 1997 over 200 watershed analyses had been completed - 69 in Washington, 12 in Oregon, and 32 in California (USDA Forest Service 1997). About 265 more will be done in another 6-8 years, and about 50 will not be attempted because they are predominantly wilderness or private, and therefore beyond the FS management mandate. Each is done by a team of natural resource specialists (wildlife/fisheries/plant biologists, hydrologist, etc.) employing a 6-step process which takes abut 2 ½ months.

The six-step process is analogous to the IPT workshop protocol:

1. Characterization of the most influential (driving) biophysical and human patterns and processes organized around 7 core topics with a set of associated key questions, suggested techniques and products. The core topics are erosion processes, hydrology, vegetation, water quality, species and habitats, and human uses;
2. Issues and Key Questions to focus the analysis on resource conditions and management issues (known problems) and to define the level of analytic detail;
3. Current conditions and trends for the core topics (details what was identified in the first step);
4. Reference conditions or reference baselines to permit change analysis and goal setting;
5. Synthesis and interpretation using the core topics to explain the changes and their causes;
6. Recommendations for watershed management and monitoring based on the synthesis and interpretation of data (#5)

The cost of such an analysis ranges between $30,000 - $300,000 and averages $90,000 for a typical 100,000 acre watershed. The first year alone (1994), 19 analyses cost $13,000,000, although greater economies were later achieved with experience.

To date however, no systematic and objective way of integrating the analysis in Step 5 is used by the Forest Service. Absence of an integrating methodology can yield unreal results which come from omitting or subjectively estimating complex interactions and cause-effect feedbacks. A good example of the consequences of not using an objective integrating method in a watershed reclamation effort, is described for log sills/wiers placed in Camp Creek of the John Day basin to moderate water temperatures, the critical limiting factor for salmonids(Li *et al.* 1992). To increase the number of pools, 280 wiers at $750 each did not increase rainbow trout density or habitat. The lesson was that "…efforts to rehabilitate stream habitat on a site-specific basis without examining the entire river and riparian landscape contributed to the lack of success of many projects (from a review of habitat rehabilitation projects by Beschta *et al.* 1991)."

Tasks: Watershed Analysis (assume four analyses are available from the Forest Service)

1. Collect all historic and currently available data, both published and grey (e.g. agency allotment analyses, comparative photographs, timber stocking, fish and wildlife counts, infrastructure development, fire history, stream modifications, etc), as well as anecdotal from on-site discussions with residents;
2. Focus on information which the model indicates is most important to goals defined by workshop participants;

II. Alteration of Stream Character

Issues - Two of the most extreme forms of stream and river alteration are complete de-watering (often seasonal) by diversion and/or pumping, and drowning reaches in impoundments behind dams. In either case the free-flowing river does not exist. Another alteration results from blocking interactions with the riparian and floodplain area though channelizing, levees, and flood control. The importance of a floodplain connected to the lotic system is described for a typical downwelling at the upstream end of a flood plain, flowing through aquifers to reappear as a sprinbrook some distance downstream in abandoned meander channels (Stanford and Ward 1992). These springcreeks have elevated nutrients, clarity and stability and exceed the biomass of main channels by several orders of magnitude forming important biological hot spots and key salmonid production areas. Such functions are often cut off in constrained channels (e.g. with roads and associated ditches and culverts).

Many restoration efforts have been unsuccessful because of inadequate analysis: the patterns of water and sediment transport determined by reference baseline stream morphology and vegetation determined from old aerial photos and maps, soil types, etc. (NRC 1992). Necessary tools of hydrology and fluvial geomorphology need to be applied. The NRC notes that in addition to the lateral flood plain linkages, restoration needs to incorporate changes upstream which are inevitably communicated in an upstream-downstream continuum of land uses and water quality. For these reasons and because the streams and rivers can be migratory pathways, the NRC analysis (1992) explicitly calls for a watershed and systems perspective (p. 175).

Design - The restoration process follows the soft engineering approach of D. Rosgen (NRC 1992) who matches the morphology of baseline stable streams which he finds in the area, to a reconstruction design for the subject stream which has been channelized and straightened leading to stream bank failure and erosion. The ensuing hydrologic problems such as broadening and shallowing, pool loss, full freezing and others are common in the west. Similar problems can come from the extensive clearing of riparian willow bottoms for hay and grazing, or pumped withdrawals (Kondolf 1990). The variables which are monitored and which will reflect the success of the reconstruction are river width, depth, velocity, discharge, slope, energy, roughness, sediment load, sediment size sinuosity, dominant particle size, channel entrenchment and confinement, soil erodibility, and stability. This is the initial step in the aquatic/riparian/floodplain area of the watershed. First, the reference channel geometry is matched to the stream and a classification of the stream is made for the region in which it is found. Then a historic review of the problems helps to determine the causes of the problems. Comparing the existing flow and form with the stable reference, a design of channel patterns, curvature and proportions is developed which produces desired flows, pools, sediment and cobbles, in the same proportions as the empirically observed natural river. The calculated cross sections to estimate cut and fill required leads to an evaluation of environmental impacts and mitigations, and the necessary permits are secured from such agencies as USFWS, State Wildlife Department, USFS, EPA to comply with the Clean Water Act (e.g. Section 404). A downstream settling pond and diversion bypass is finished so channel work is done in a dry streambed. The active channels are staked and aligned using a laser level, and construction is completed in low water periods. The bulldozers and scrapers transform the river from a shallow, braided stream impacted by grazing, logging and roads which is not likely to self-correct. Once the correct geometry (and cross-sectional dimensions) are attained, flow patterns are further determined by bank revetment work, using native materials such as logs, boulders, root wads, and live vegetation. Riparian cover is established with woody (e.g. cottonwood, willow) and herbaceous bank cover (timothy, bluegrassess). Banks are stabilized by sinking logs and boulders in layers, covering them with soil, and planting them. The results include new meanders, deep pools, new flood terraces, re-constituted flood plains, riparian vegetation, and stabilized natural appearing banks.

Tasks: Channel Restoration and Riparian Revegetation

1. Identify nearby baseline stable reference streams;
2. Inventory/Monitor/map stream width, velocity, discharge, slope, energy, roughness, sediment load, sediment size, sinuosity, particle size, entrenchment, soils, vegetation;
3. Classify stream/Historic cause-effect analysis of problem;
4. Design channel/Estimate cut and fill, equipment;
5. EIA/Permits;
6. Construct temporary bypass and settling ponds;
7. Survey and stake alignments;
8. Construction/Place revetments, barriers, culverts;
9. Revegetate, where needed.
10. Line or pipe ditches/Fish screen ditches.

III. Grazing and Range Management

Issues - Behnke and Zarn (1976, cited in Platt 1991) state that livestock grazing is the single biggest threat to salmonid habitat in the west. Grazing is permitted on over 90% of federal lands in the 11 western states where federal land constitutes about half of the total land area (Armour *et al.* 1991). In addition to this 45 % of the land, 32% is private range, a total of 77%. Between 1/2 and 2/3 of these federal rangelands are in classed as in poor to fair condition. Although there are 332,000 miles of streams requiring some review and management in Washington and Oregon (Naiman 1992).

The elimination of riparian vegetation by foraging (direct removal), compaction, or through bank failure leading to loss of vegetation (Berwick 1978), leads to loss of associated fauna, lower water table, channel widening, poor water quality from nutrients and sedimentation, and cascading related changes such as increased water temperature. A northern Nevada stream under heavy use went from 8 to 13 m in width. A stream in Utah which had been rested 10 years was compared with nearby grazed areas. A 40% increase in stream width and 45% increase in bank angle resulted from grazing. To illustrate one possible feedback relationship, water pumping/diversion, overgrazing and riparian logging leading to loss of riparian vegetation will drastically lower the value for beaver which consume willow, aspen, cottonwood, and other associated vegetation. Loss of beaver means no beaver dams which divert water to side ponds and channels, reducing extreme flows and enhancing diversity including fish and waterfowl habitat. Further, sediment is reduced by 90% below beaver dams. There is a 400% increase of salmonid rearing sites which can be more limiting than spawning areas (Swanston 1991).

Design - Sheridan (1986) has estimated dryland restoration costs ranging from \$60 - \$ 3000/ac. Land imprinting (holes drilled for water infiltration) and bulldozer rilling (water collection ditches) at \$25 and \$200/ha, innoculation of seedlings planted with mycorrhizae, native grass mixes seeded at \$45/ha are some of the range restoration options. Fencing (\$3500/mile) and institution of grazing control systems are also common restoration actions. In addition to stream reconstruction, grazing management and revegetation, a combined erosion control-riparian reveg technique known as Vleckport reclamation is described by Heady and Child (1994). It is spectacularly successful but otherwise similar to other varieties of check dams.

Typically, about half of an average watershed can be considered range (including open forests). R^3 for 100 mi^2 will involve restoring 10 mi^2 of reseeding and browse plantings, 5 miles of fencing on each side of riparian zones, and 100 miles of pasture fence.

Tasks: Range Restoration and Management

1. Contour trenching/rilling;
2. Seeding and mulching;
3. Tubing/Planting;
4. Fencing riparian (both sides) and upland pastures;
5. Gully stabilization and reclamation.

IV. Timber Harvest and Roading

Issues - Logging can be a major source of watershed disturbance. The activities associated with logging include felling, yarding, site prep, fire reduction, regeneration, tending or reducing competition by brush removal and thinning, road building, and chemical applications. The smaller streams (2^{nd} - 4^{th} order) where most logging occurs in the watershed, are also where most spawning and rearing of salmonids occurs and which are most impacted by logging (data below from Chamberlin, Harr, and Everest 1991). Large clear cuts (over about 1000 ft. diameter) have more snow and release it much faster (e.g. 38% faster in a 5000 ft clear cut in British Columbia, 40% increase at the Andrews forest in Oregon). Small cuts average a 20% increase in melt water runoff. Therefore, it is good to desynchronize cutting. Roads and skid trails are the primary sources of sedimentation. Studies in the coast range of Oregon show increases of 2 - 22 fold from clear cuts, and 20 - 350 fold in slides from roading (Hicks *et al.* 1991). Pools decrease, riffles increase, gravels are sedimented, and obstructions to migration increase. Increased solar insolation results in an average monthly increase in small stream temperatures of 8^o F. Cable logging increased sediments 0.6 fold, where as roads increased sediment 220-fold. Over 85% of sedimentation above natural levels in a cut was due to roading. A 7% cut on the 19 mi^2 Dollar Creek drainage required about one road per mi^2. With simple mitigation such as moving fill off-site, a 46% reduction in sediment was realized. With drainage filters, graveling the road, and seeding cut and fill, sediment as reduced 76%. With helicopter logging, a 98% decrease was measured. Clearly, the roads generated the sediment which reduced fish production to less than 20% of potential.

Design - Reforestation needs to speed up succession. Seedlings planted with innocula (above) shortly after cutting will generally permit desired survival and spacing. Several steps are involved in reforestation (Horowitz 1990):

- more thorough site evaluations which do not use regional formulae as much as ecological interactions and features (shrubs, snag retention, standoffs, etc);
- skilled planting;
- use of healthy and adapted seedlings, preferably of a native provenance;
- greater use of species mixes to avoid a vulnerable artificial monoculture;
- wider spacing reducing the need for early thinning.

Tasks: Reforestation, forest and slope stabilization

1. Site evaluation for standoffs, snag/dead wood, and shrub retention;
2. Train planters/Plant seedlings with innocula;
3. Decommission roads (seed)/Install drain/culvert filters.

V. Restoring watershed wetlands

Issue - As dramatic as the loss of old-growth forest in the watershed, has been the loss of wetlands from riparian zones. Wetlands continue to be lost at a rapid rate (about 460,000 acres/yr). About half of pre-settlement wetlands have been lost and in some areas such as California, over 96% (see Tiner 1984). Wetlands purify the water delivered to streams, retaining sediments, heavy metals, fecal coliform and denitrify the water (Pastor and Johnston 1992). The quantity and quality of the water delivered from 15 watersheds was studied by Pastor and Johnston (1992) who statistically analyzed 33 attributes. The most important determinant of water quality (29% of the variance) was wetland extent followed by wetland position (14%), and others such as ratio of agricultural to urban land, length of streams, watershed diversity, forested riparian area, etc.

Design - A brief outline of the requirements in a typical 200 mi^2 watershed would include:

- **wet meadow restoration** (Zeedyk 1996)- grazing impacts and their mitigation have been described above. Road management practices which impact wet meadows include building on them instead of alternative alignments, installing channel crossings below gradient thereby accelerating runoff and channel incision, installing ditches and drainage ditches below meadow surfaces leading to gully erosion, diverting surface and groundwater from meadows causing them to dry, surfacing roads with inappropriate aggregates leading to sedimentation, and borrowing gravel and fill from stream channels. Remedies include realigning roads, raising culvert inlets with geotextile based encased rock berms for 20 ft upstream of the culvert ($200/ structure), drop inlets so that water drops around railroad tie weirs to the culvert ($500/structure), rerouting ditches, berms, and cross drains which divert runoff from roads as well as meadows**,** using closely spaced lead-out ditches and culverts to distribute water to the meadow, and planting buffer strips while reducing use of them by livestock by fencing;

- **agriculture to wetland conversion, levee setback, and impoundment modification -** These are the most common remaining wetland restoration activities which biologists and engineers at Ducks Unlimited confront in the Pacific Northwest. We have estimated costs for these related and common activities. Generally, existing levees will still need to be maintained to a degree for effective flood control, although they can be moved back and selectively breached. Pumping is avoided in favor of gravity flows if possible. Examples are the Wood River in the Klamath Basin and Toppenish and Satus Creeks in the Yakama Indian Nation. Often these activities co-occur at a site and are packaged. Average costs per acre for 9 separate projects are (not every activity is conducted at each site):
  survey and design - $ 65
  materials - $ 93
  land leveling/berms/levees - $ 244
  construction management - $ 39
  labor and equipment - $ 45
  culverts - $ 375
  total project cost/ac - $ 534 [1]

These averages are influenced by economies of scale - the larger the project, or the more activities occurring at a site, the less per acre cost. Since they do not include permitting costs which can amount to 10-15%, the likelihood is a per acre average of $600. Although these costs are real, DU engineers were asked to estimate maximum total restoration costs (permitting, design, and restoration) which were likely to be encountered for projects of different sizes (Charney, pers. comm.). At 30 acres, costs could reach $8000/acre, for 100 acres they could reach $4000/acre, and for 300 acres, $ 2500/acre. We estimate a crude but realistic 1% of the typical watershed as requiring wetland R^3 - 2 mi^2 of 200 mi^2. A further 1% will require wet meadow rehabilitation.

Tasks: Watershed Wetland Restoration

[1] Note: 1996 dollars and costs which do not include permitting, contracts, acquisition or easements which must be established before work is initiated

1. Wet meadow road re-alignment;
2. Raising culvert inlets, placing drop inlets in wet meadows;
3. Re-routing ditches, berms and drains and installing closely
spaced culverts and lead-out ditches in wet meadows;
5. Riparian-wetland restorations./Levee setback/breaching, floodplain liberation;
6. Returning agricultural fields to wetlands;
Modification of impoundments (e.g. reservoirs arm) to wetland;

End of Project Description- Associated References/Literature cited

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SECTION 9. Key Personnel

Crafting just the right team is always one of the most important guarantees of success. It is particularly critical to the type of integrated systems approach advocated here. Not only does the right mix of capabilities and technology need to be marshaled, the coordination of the whole effort requires the command, control, and communication capabilities not often found in natural resource management. Furthermore, the emphasis on planning ***and*** implementing with quality with speed points to the biological orientation and hands-on experience of a private sector eco-engineering organization like Ducks Unlimited. DU is proposed as the prime contractor for this effort. It is arguably the most experienced and respected restorer and enhancer of riparian and wetland ecosystems in the world, filling this function for, among others, the US Fish and Wildlife Service on many of their refuges. Furthermore, we are the organizer of teams of “Partners” for the ecosystem and flyway-based Joint Ventures of the North American Waterfowl Management Plan. The 60-year history of DU features the integration of hydrology, engineering, and biology. It also features extensive work with private landowners with results that can be seen on over 7 million acres of the landscape. The Western Regional Office of Ducks Unlimited will take the lead for this managing this project.

Table 2 outlines the team members and their responsibilities. Detailed descriptions are given in attached CVs.

Table 2. The Project Team (tentative and will not include all for first phase)

Organization/Location	Lead(s)	Responsibilities
Ducks Unlimited, Sacramento CA	Dr. F. Reid A. Engilis, M. Biddlecomb Robert Charney Dr. S. Berwick	Project management Biological Restoration Restoration Engineering Workshop facilitation Restoration/construction
Nez Perce Tribe Lapwai ID and Enterprise OR	Si Whitman Don Bryson Ira Jones	Watershed Lead, workshop, implementation contracts
Yakima Indian Nation, Toppenish WA	Tom McCoy Dr. Bill Bradley	Watershed Lead, workshop, implementation contracts
Salish-Kootenai, Pablo MT	Joe Dos Santos	Watershed Lead, workshop, implementation contracts
USGS/MESC	D. Hunter	Data acquisition/mgt
Washington State Univ, Spokane, WA	Dr. A. Ford	Systems plan and simulation
Resources System Group	R. Chamberlin S. J. C. Lawe	Systems plan and simulation
Portland Energy Paradigms	P. Barton	Systems plan and simulation

SECTION 10. Information/Technology Transfer

Workshops will be conducted to yield models for implementation of habitat restoration. Results will be placed on the web for concensus building among stake holders. DU will oversee habitat restoration work.